WIRELESS EHEALTH APPLICATIONS: ARE WE ON THE RIGHT TRACK?

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ABSTRACT

Due to the proliferation of wireless technology in the past 24 months, emerging software solutions to healthcare problems assume the option of 'mobility' for many medical professionals such as doctors and nurses. Inherently these professionals are mobile and hence the assumption that mobile solutions would provide significant performance improvements is valid. However, due to the limited knowledge available to development teams about the various requirements of the healthcare, and due to the difficulty in understanding how the health information systems function at an organisational level, it appears that the wireless eHealth solutions developed to date appear to be performing below the expected level. This review paper, from practitioners' identified various guidelines provided in developing wireless solutions and matched them with two specific solutions presented in 2004 HIC conference. The analysis, based on the presented information, indicates that there is a glaring gap between the practitioners' literature and the current practices. Hence the question, 'Wireless eHealth Applications: Are we on the right track?'. This paper does not attempt to answer this question but opens up a number of questions that will be investigated in depth in 2005 so as to seek answers to the wireless eHealth development phenomenon in the Australian healthcare industry.

KEYWORDS

wireless technology, healthcare, technology management

1. INTRODUCTION

Wireless technology has started making in-roads in healthcare applications due to its mobility and flexibility. For instance, in Australia, many healthcare providers use wireless in the form of PDAs, Bluetooth protocol, radio wave based wireless and other IEEE standards and predominantly used in many Australian healthcare to solve 'local' problems where ad-hoc solutions are provided at department or unit levels. Examples of these wireless solutions can be found in Fremantle hospital in Perth, Government hospital in Western Sydney and Base hospital in Toowoomba, Queensland. Common to most of these wireless development include user needs at a department level, enthusiasm exhibited by IT people working in these hospitals, push for innovative solutions to solve existing problems, complications in establishing wired networks due to cost, drive by the executive officer to trial innovative solutions (usually read in a magazine while travelling) and to test 'proof of concept'. While these appear to be common to the wireless development in the Australian healthcare, in many cases, it also appears that there is no organisation wide planning to implement wireless technology as the technology appears to be in its infant stages. Many studies conducted in the area of healthcare, specifically telehealth, have clearly identified the lack of management of technology as a major concern for failure in implementing IT technical solutions in healthcare (Railsback, 2001; Rogoski, 2005; Smith, 2004; Zhu et al., 2005).

Previous studies in the area of telemedicine clearly demonstrate that innovative technology solution alone is not sufficient to solve the problems encountered in healthcare. For example, access to services is considered more important than introducing new technologies to reduce costs (Anogeianaki et al., 2004). The access discussed in many telemedicine studies includes access by medical practitioners as well as public, both in metropolitan and rural areas. These studies highlight the need for a management plan to provide sustainable accesses to medical services using IT. Yet another study in the area of Internet based palliative home care concluded that technology alone will not solve the problems encountered in this domain (Bensink et al., 2004) and management of technology is cited as the main reason for any success in this area. The implementation of a web based teleradiology system did not deliver expected results and user errors were cited as the main reason for failure of implementation (Caffery & Manthey, 2004). The management's attitude in assuming that hospital users are computer literate was cited as a major reason of failure. It should be noted that in many IS literature, training has been identified as the top 20 factors of success since 1980. Despite these findings, it appears that current implementations in wireless technology ignore the aspect of training. This is because IT training in ad-hoc systems is not a management priority and this perhaps resulted in new implementations failing as users found these systems complex to comprehend.

Therefore, it can be argued that, while technology advancements provide solutions to existing problems, the successful implementation of the solutions are dependent upon establishing a proper process to develop and deploy these technologies. This is evident in many prior cases, where, despite the availability of technical infrastructure, organisations struggled to implement technical solutions developed using IT innovations. This is a concern because the investment made in developing these innovative solutions are not fully realised by organisations and hence imply failures. Given the nature of current healthcare stats, where many healthcare organisations are struggling to balance their books, one gets a feeling that we are not on the right track. In essence, current ad-hoc wireless solutions in Australian healthcare appear to have failed in addressing problems despite the availability of adequate infrastructure.

2. WHAT SHOULD BE CONSIDERED TO MANAGE WIRELESS SOLUTIONS IN A GIVEN SETTING?

The question that needs to be answered urgently is 'What should then be considered?' for proper eHealth wireless technology solutions. This is because the current trend appears to be delivering wireless solutions without clearly addressing the needs at organisations levels and this has introduced difficulty in managing wireless eHealth solutions as an enterprise application. Practitioners literature (not academic publications) clearly states that any wireless deployment at organisational level should consider limitations of the hardware including network infrastructure, proper software architecture designs that can bind existing data model with the new wireless systems, user interfaces to accommodate different types of users, configuration of the wireless LAN, IP address assignment issues due to the dynamic and mobile nature of users, security features of both data and network, authentication methods as users may use different types of devices and hence varied types of addresses, file sharing procedures as data can emerge from any mobile device including graphics and sound files, performance issues as wireless can become unreliable in certain conditions such as stormy weather, training as users may not be familiar with new devices and their functional elements and finally cost issues.

Therefore, to deploy a proper wireless solution, an organisational wide plan is necessary as the implementation will affect the entire organisation. It appears that current projects[1], sadly, are developed to address some compartmental issues without a long-term view and hence fail to provide benefits to the organisation. Therefore, if organisations are keen to provide wireless solutions, then they should consider a step wise implementation of wireless technology. While the detail description of how to implement these steps is beyond the scope of this paper, practitioners suggest the following.

[1] A later section provides details of this aspect.

Evaluate organisational needs: This stage of wireless implementation would establish user needs in order to provide wireless solution. It may so happen, at this stage, that a simple solution without wireless can be provided. If wireless is the only solution, then the impact of adding wireless to the organisational IT needs to be evaluated very carefully because once the wireless is added, it is difficult to remove as users will demand more of it.

Plan organisational wireless needs: During this stage, organisations should evaluate the type of wireless technology that is most suitable to the organisational need as this is when the cost figures will compound the problems. Further, any such evaluation should also consider the time frame to ensure long term sustainability of wireless technology in the organisation.

Plan a trial wireless rollout: Due to the 'hype' in this domain, and due to the rapid hardware development cycles, new products are emerging in the market on a daily basis. Therefore, it is better to have a conceptual model to start with, develop a solution and trial it out before any big scale deployment.

Test the wireless implementation to ensure that it meets organisational objectives: Testing at organisational level is crucial. The projects examined in this paper, while successful in unit level testing, appear to be not addressing organisational level testing. In the projects developed by Gururajan (2003), the wireless system did not function well when tested at another branch because the conditions were different in that branch due to State legislations.

Train users: This appears to be crucial in many healthcare wireless implementations as paramedical staff appear to be intimidated by new technology. Further, wireless interfaces may differ from traditional desktop computers and users may be confused with these interfaces.

Security: Organisations should have a management plan to implement security policy including physical, data and information security. The plan should be made available to employees and should be revised to address any emerging issues.

Implement a production rollout: This is the stage when all components of the wireless systems at organisational level are implemented at the same time. It is essential to integrate all systems at some point of time to change over from existing systems to wireless systems and the overall changeover may bring out some unexpected problems. One such problem can be traffic load. These issues should be considered well in advance and addressed.

Plan for ongoing maintenance: Ongoing maintenance is crucial in wireless implementation for many reasons. For example, users outside the organisation may use different hardware and software platforms and it may be necessary for the organisation to provide support to these users. Devices need to be upgraded to meet industry standards. Security protocols may need upgrades. These are challenges to organisations and should be well thought about prior to full implementation. Due to these challenges and ever increasing costs of software maintenance, current wireless developments are restricted to unit level without being extended to organisational level.

3. THE NEED FOR WIRELESS TECHNOLOGY SOLUTIONS IN HEALTHCARE ENVIRONMENT AND ITS CURRENT STATUS

Wireless Information Technology is used in healthcare settings due to the flexibility and mobility offered by the technology (Wisnicki, 2002). Wireless technology includes the concept of mobile computing, which consists of portable devices that can connect to traditional networks without the utilisation of cables (Simpson, 1996). In healthcare settings, this technology can be used to access data about a patient, to enter certain predefined terms in order to process billing details or to capture patient data at the point of entry. Common to all these activities is the transmission of data from a mobile device at the point of care to an

existing legacy system commonly found in healthcare settings (Stevenson, 2001). Current healthcare systems, due to the ever-increasing costs and due to the complexities in managing the patient data and associated information such as billing and pharmaceutical information, are not functioning at its expected level (Davis, 2002). This has, in turn, compromised the level of service provided to the customers of healthcare systems including patients and doctors. While it is possible to point out that these problems can be sorted out with proper integration and access to systems (Craig & Julta, 2001), it is also possible to argue that wireless technology will be able to provide better access to data from anywhere at any time (Stuart & Bawany, 2001). This notion has prompted healthcare organisations to consider wireless solutions in their overall information technology development.

The need for wireless technology in healthcare is justified by many studies as a solution to the financial crisis encountered in many healthcare systems (Davis, 2002), to address the increasingly complex information challenges (Yacano, 2002), to comply with the rigorous regulatory framework (Wisnicki, 2002), to reduce the medication errors (Turisco, 2000) and to generate affordable healthcare applications that allow for greater mobility and ease of use in entering, sending and retrieving data (Athey & Stern, 2002). While this justification appears to be valid, it should be remembered that wireless technology would not solve all problems encountered in healthcare (Wisnicki, 2002). These devices are still in their infancy stages and slower in speed compared with the desktop computers (Shah, 2001), high costs to initially set up these may be warranted (Shroeder, 1999), lack of real time connectivity due to the mobility of the device (Stevenson, 2001), the size of the screen and hence the problems that may be encountered to display data (Toms, 2000), little or no provision for high quality graphic display (Atwal, 2001) and hard-to-see display (Bevan, 2001). These appear to be impeding the progress of wireless uptake in hospital settings.

After examining a specific wireless solution in the Australian healthcare, (Railsback, 2001) questioned the planning methods and concluded that many current installations of wireless solutions in healthcare appear to have inadequate planning methods. While this is implied as a major source of failure, Railsback identified training to users to be a major factor contributing to success. The training management plan is identified as a key factor for proper implementation of wireless in an organisational setting. Further, according to Smailing (2003) many studies in healthcare have ignored the essential need for an enterprise perspective for wireless deployment. This is essential as wireless technology is believed to provide a radical shift in the way enterprise data are managed and accessed. Smailing warns the initial successes of wireless development in organisations are short lived because of the lack of enterprise strategy for wireless solutions.

The aspects of management policy to integrate wireless solutions with enterprise systems are indicated by (Chau & Turner, 2004). They indicate that while there was support from middle management to the systems developed for the healthcare, there is no explicit reference to an organisational wide deployment of this wireless solution. Johnson (2004) provides a comprehensive approach to organisations to realise value from technology solutions, subtly indicating the necessity for strong management policies for such development and proper integration and management of new solutions. The approach taken by Johnson includes a project management approach. Crow (2004) provides details of a wireless solution developed in a hospital in Melbourne, Australia and emphasises the need for management of this solution at organisational level, including developing policies and procedures to properly integrate this system with other existing systems.

Management issues of wireless in healthcare were discussed in terms of wireless capacity in rural areas, implementation process, methodologies for Quality of Service (Saroka, 2000). Specific issues relating to infrastructure were also addressed by prior studies in terms of growth and hence revenue prediction. A major criticism in this area appears to be the lack of knowledge possessed by developers in terms of available technologies and proper planning of development. In essence, the project management capabilities of wireless solutions are critiqued by previous studies. In essence, there is support from recent studies to indicate that while the technology infrastructure is available, management directive is still evolving in healthcare to integrate wireless solutions to realise benefits at enterprise level. In many healthcare organisations either the PALM series PDAs, Windows or Digital Tablets are used for the wireless development as these three appear to be the preferences. Many wireless solutions, in order to realise efficiency gains in the healthcare setting, address three major issues of wireless development, namely, (1) development methodology in order to properly integrate the new solution with the existing solution, (2)

communication issues between the mobile device and existing databases and (3) user interfaces in order to capture data that is accurate and timely as these are the three most common issues in healthcare IT systems. There is another emerging issue, 'infrastructure' essential to support wireless and this is beyond the scope of this paper. However, where needed, this aspect is briefly covered.

Current wireless solutions in the Australian healthcare appear to be hindered by a number of limitations. These include the code, integration with existing applications, user interfaces and data transmission. The code was written as generic as possible and parameters were kept as variables to allow flexibility. During real time testing, some of these parameters caused run time errors, as the compiled code was not able to resolve certain data types prior to the run. This created the necessity to re-visit the code and examine every instances of the run in order to remedy the problem. Integration with existing applications caused concern, as the healthcare industry did not have uniformity across all branches, data redundancy still exist, causing adverse performance influences and the applications developed by the national office followed national standards while local branches followed their own ad-hoc standards. The development environment (Java libraries) used for the development was superior to the existing environment and caused problems while the product was tested in the healthcare setting, as some libraries were not available in the existing environment. These caused minor difficulties while integrating the wireless application with existing applications.

Data transmission issues introduced certain limitations. While some prototype applications were tested using the infrared technology in a closed environment, the 'line of sight' required by the infrared created some limitations as it was not be possible to guarantee the line of sight always due to the sensitive nature of the emergency department. On the other hand, Bluetooth technology (another wireless technology) did not provide acceptable levels of coverage. It was not be possible to transmit data using wireless technology alone, as some branches of the healthcare were about 400 KM from the national office. These issues are being investigated currently by some healthcare organisations.

Thus, the wireless solution provided address mainly software issues and limited organisational need. The limitations imply that the solutions developed did not consider organisational wide deployment and appeared to be short-term fixes to existing problems where wireless technology is used as a trial.

4. AN ANALYSIS OF HOW AND WHY THESE WIRELESS SOLUTIONS DID NOT PROVIDE EXPECTED BENEFITS – TWO SPECIFIC CASES

This paper analysed two specific wireless solutions developed in Australia. The first implementation was a trial project in Tasmania where a wireless handheld clinical system was implemented and tested (Chau & Turner, 2004). The second project was a wireless communication system deployment in an emergency department in Western Sydney. Details of these projects were obtained through the 2004 HIC conference proceedings (Hession et al., 2004). The discussion provided in this paper is derived from the details found in the published paper and the scope of the inference is limited to the details as found in the conference proceedings of 2004 HIC conference.

The solution provided by Chau & Turner (2004) was a trial project in Tasmania, Australia and addressed data capturing needs using PDAs. The study reported by them did not describe any project management techniques, software development techniques, security and privacy issues, cost benefit analysis, software testing and software management. The implication of the development is that the wireless infrastructure is available with in the organisational context and hence a solution can be developed. As mentioned in the opening paragraphs of this paper, the development team did not study the issues to establish that wireless is the solution for the problems encountered in data capture. Further, the software development did not provide any cost benefit analysis of the new solution. Therefore, it is not possible to ascertain whether the new solution was superior in terms of performance, cost etc. Practitioner's literature in wireless domain clearly states the necessity to assess the demand, choose a relevant solution, manage the solution at enterprise level in order to reap benefits of wireless technology. The solution provided by Chau & Turner appeared to have

ignored these guidelines as there was insufficient evidence in their paper. Therefore, it should be assumed that the wireless solution, even though, met the objectives of the development, did not address the practitioner's guidelines and may not sustain in the long run. Further, this solution, it should be assumed, will not provide organisational wide benefits because the solution did not consider any of the organisational objectives.

The wireless development in Western Sydney by Hession et al. (2004) measured communication efficiency in terms of speed and reported satisfaction from users on this aspect. The project was restricted to the emergency department and the project met the objectives of the software development, as in other projects discussed above. The project considered wireless infrastructure issues and developed a wireless local area network. This infrastructure was further linked with an innovative speech recognition system in conjunction with the local switch board that handles telephone communication. Despite the clever use of wireless infrastructure, the project did not address change management, reduction in data error and other common themes identified in the healthcare literature. Further, the data that emerged from the wireless network was restricted to the emergency department and how this data were further integrated with the organisational database was not clear. The project did not state whether the wireless development was initiated by the management, and whether the project would be extended to other departments. Considering that there is no clear evidence as to the continuity of the wireless project to other sections of the organisations, one would assume that the project is a stand alone activity and did not address management objectives at the organisational level. Therefore, organisational wide problems could have not been addressed in this project.

A brief investigation into these two solution indicate that it is possible to argue that wireless technology in the Australian healthcare sector is developed without following the guidelines provided by practitioners. Further, in the projects examined, the concept of security is seldom addressed in detail. The privacy principle guidelines have not been considered in any of these projects. The data integration issues, especially the method through which the data arising from wireless devices would be integrated with existing organisational data, were not discussed. Further, there appears to be no project planning, cost issue discussion, demonstration of benefits to organisation as a result of wireless implementation and the change management plan in most of these projects. Further, the healthcare issues identified in the literature and how wireless technology might be a solution to address these issues, were not established in all of these projects.

Based on the examination of existing literature and the wireless projects developed in Australian healthcare, one would conclude that the solutions were provided because of the enthusiasm of the technical and clinical people to resolve some of the local issues. These solutions appear to be successful due to the relatively affordable cost at department level and the local expertise available within the department. While management appears to have supported these projects, there is no evidence that these projects were the objectives of the management. Further, issues relating to management of security have not been given importance leading to potential security vulnerabilities. Therefore, these projects should be seen as answers to existing problems due to available wireless infrastructure without proper consideration of management objectives at organisational level. Hence, none of these projects would have addressed management problems.

5. THE GLARING GAP

If the wireless projects examined did not provide solutions to address management problems, the question that still needs to be answered is 'What should then be considered?'. It appears that the wireless development in the Australian healthcare is ad-hoc, demonstration of the ability of providing a solution, unit based and in many cases a trial. The gap between the practitioner's guidelines and the real development appears to be the following:

1. The solutions examined did not consider organisational goals: This is particularly true in the two specific cases discussed as the integration of existing systems was not considered by these two solutions to a satisfactory level.

2. The solutions did not provide details of organisational wide wireless needs: A major problem in many wireless solutions developed in the Australian healthcare appears to be the lack of organisational needs. In many cases, an organisational wide assessment for wireless needs was not performed. This includes the necessity to identify the type of devices, frequency of usage, range, change over from current practices to new wireless based forms etc. It also appears that this lack of organisational wide requirement encountered resistance (from the IS units) when an organisation wide implementation was planned based on a unit solution.

3. Lack of trial roll out: In many cases, the load testing and the range testing was not evident implying that these were not considered by the developers. While wireless offers significant benefits in certain quarters of an organisation, in the health environment, 'down time' of systems is not acceptable. The wireless solutions examined did not provide details of this aspect.

4. Ongoing maintenance: This aspect was not thought out as there was no evidence in the published documents as to how this will be managed. While current needs appear to have been met with, emerging needs and the long term continuity of these solutions appear to be still emerging. One reason for this may be due to the infancy of the wireless technology as applicable to the healthcare. However, organisational wide planning is essential as this will consume financial resources.

While there are other glaring gaps such as training to users, appropriate selection of devices and operating environments, the above four points assume paramount importance in an organisational IT development & management context.

6. CONCLUSION

This paper examined two specific wireless solutions developed in the Australian healthcare sector to find out whether these developments comply with the practitioner's literature. It appears that these two solutions examined in this paper, while achieving limited objectives, failed to address the points highlighted in the practitioner's literature, especially in developing wireless solutions. The wireless technology, which was hailed as the solution to some of the problems of the healthcare industry in Australia, is implemented to address some local issues but not organisational issues, and did not follow any formal processes. Therefore, it can be stated that despite the initial success of these wireless solutions, the problems are not yet fully addressed by these solutions in a comprehensive manner. In fact, the guidelines provided by the practitioners literature is not followed by the studies examined. The studies did not detail how the data emerging from the wireless solutions will be integrated with existing data, and how the change management practices will be implemented. Due to the lack of information on these two, one would conclude that, despite the availability of technical infrastructure to provide solutions to healthcare management issues, we are still not on the right track. Therefore, one would conclude that the current status of wireless solutions provided in the Australian healthcare did not realise in superior gains for organisations. This may be due to the relative newness of the technology as applied to the healthcare. Future wireless solutions for healthcare should take practitioner's guidelines into account while planning wireless solutions as we can learn a great deal from those who have done it!

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